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the independent journal of energy conservation, building science & construction practice

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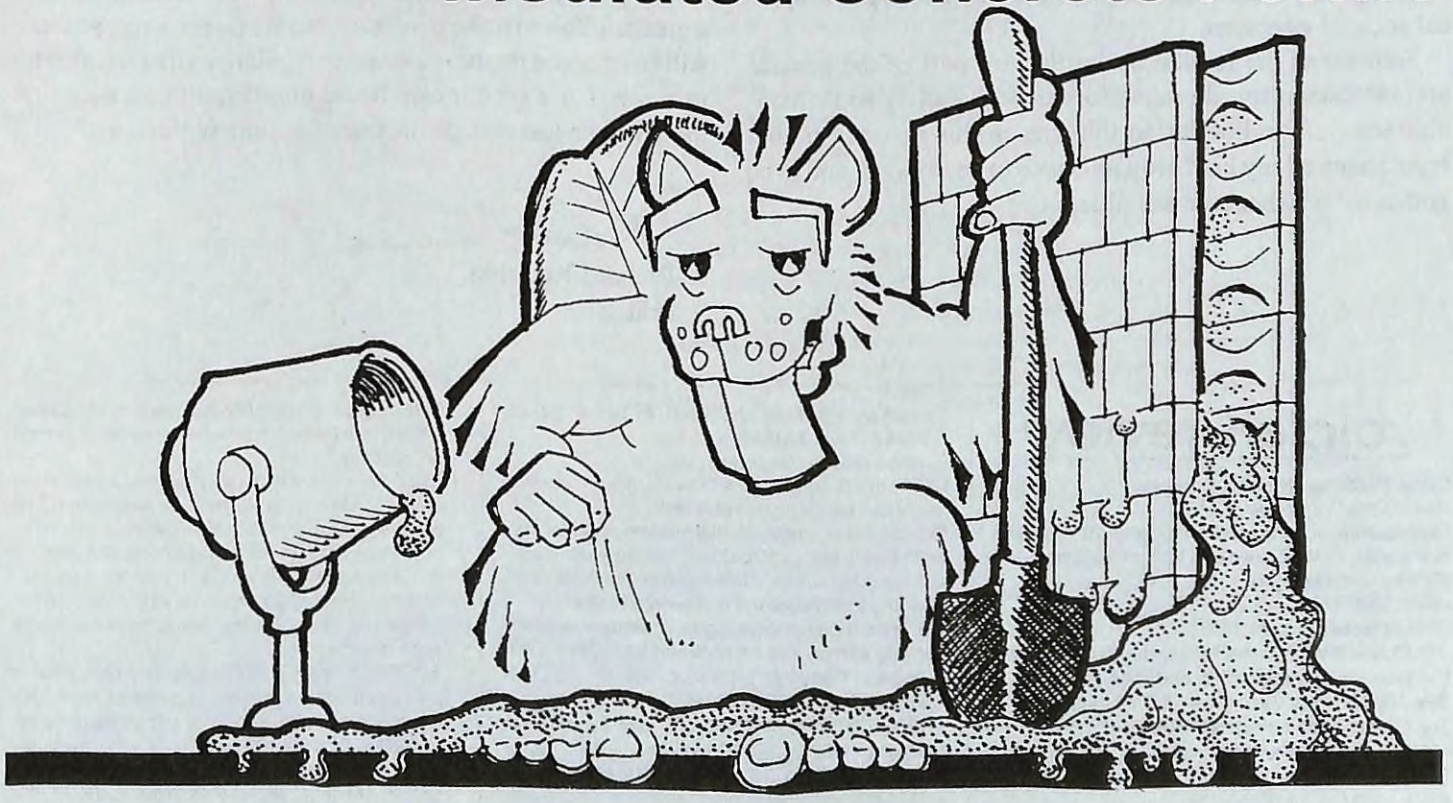
Insulated Concrete Forms



From the Editor . . .

Building is a creative industry. Each new venture, be it for a new building or a renovation project, is a creative act. This includes not just the architect, who creates the basic design, but also the builder and the trades person on the job. Most of us get a great deal of satisfaction out of this activity or else we would not be sticking with the industry through bad times, through fair weather and foul.

When I started Solplan Review in the early 1980s, it was a rather uncertain time economically (is it ever any different?). At the same time much creative energy had been unleashed because of the energy crises of the late 1970s. The energy crunch of the time drove building innovation, as everyone was searching for a better way to reduce reliance on energy use. The fallout from this activity led to innovations. Not all were directly energy related, but they did improve the housing we produce.

Solplan Review was started to provide a vehicle to report on the latest findings to the building industry, as there was no other medium to deliver technical information. As I look back on the past years, I can also see another development. It seems we are spending more time today on regulatory issues than on technical problem solving. Many of these regulatory issues are not purely technical, but more broadly based philosophical societal concerns.

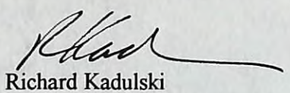
Sometimes the regulatory battles are part of the general anti-establishment, de-regulatory drift in society so fashionable today. The libertarian thinking in this instance is that regulations of any kind are a nuisance to be avoided, and to be gotten rid of whenever possible.

On the other hand, there is evidence that even the current regulations are not enough, and there is a clamour for more. The "leaky condo" situation in BC is a case in point: despite codes and seeming common sense, there was a total breakdown of the unfettered free market. It is ironic that even the most vocal critics of current regulations have been suggesting that now new regulations are needed! Of course, when new regulations are proposed, the argument pops up about there being too much red tape, and that having all these rules, regulations, inspections, and so on is not necessary.

Unfortunately, we lose sight of the fact that all those rules and regulations were created because of real or perceived problems. In a perfect world, where everyone was an ethical professional doing their work carefully, there would be no need for regulations.

Is there something in human nature that makes many of us secretly want to be told what to do when? Just look at the many instances where private sector activities are organized and run under draconian rules. The ordinances created by private clubs, condominium projects, and even developer covenants make many authoritarian politicians look weak and lacking imagination!

The point I am trying to make here is that we need to make a greater effort to make sure that what we do is correct so there will be less need for the prescriptive regulations that so often tie us down. Let's get our own house in order, and we may find there will be less outside pressure for more regulations.



Richard Kadulski
Editor

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Street address:
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Concrete Construction
Insulating Concrete Forms

Concrete offers:
- *Soundproof construction*
- *Superior fire resistance*
- *Structural strength to withstand hurricanes and tornadoes*
- *Thermal storage capacity for passive solar heat storage*

Concrete is the most widely used building material on earth. It is an inert, nontoxic product with the natural properties of the stone from which it originates, and a few unique qualities of its own.

It is durable (actually getting stronger with age), easy to maintain, does not rust or rot, and is insect-proof. Concrete is created on an "as needed" basis, reducing the waste inherent in sheet goods and dimensional products used for framing. Depending on the type of form work used, concrete construction can mean less waste that goes into landfills.

Concrete is a fluid material that is easy to mould into any shape before it sets. This property also presents one of the biggest challenges for concrete work: it must have forms to contain the concrete paste until it sets. It is the form work that uses a lot of other material, usually wood. Depending on the design of the building and local practices, a large amount of the wooden form work gets wasted while dismantling the forms.

The cement industry is presently making the pitch that concrete is not just for foundations and driveways. It can also be used for walls, siding, floors and roofing. They like to remind us that every time you build a house, you use about 41 trees for the floors, walls, roof, and, in the interior, for structure and finishing.

However, worldwide the manufacture of cement itself is the single largest industrial source of greenhouse gases. This does not mean concrete should not be used, because the durability of the material often outweighs the greater embodied energy content compared with wood or steel. However, when concrete is to be used, it should be used wisely.

The vast timber resources and the flexibility of wood framing have been the major reason for the predominance of wood construction in North America. New forces - social, political, ecological and economic - virtually guarantee that the increase of lumber prices is a trend that will not go away.

Concrete construction requires moulds to shape and form the concrete. Depending on the type of formwork used, it can be labour and material intensive, or quick and easy.

One of the more exciting developments recently is the appearance of insulating concrete forms (ICF). Insulating concrete forms combine framing, insulating, and sheathing into one easy step. ICFs also eliminate the need for a separate air barrier as the solid concrete provides this naturally.

There are two basic types of ICF forms: planks and blocks. Most are made of expanded polystyrene.

Planks rely on rigid polystyrene panels that may be notched or specially moulded to interlock and receive plastic or nylon spacers. These systems resemble conventional form work.

Blocks are factory-assembled units that may resemble a large hollow concrete block. Most have a design with interlocks so that the modules are stacked on site, like a giant Lego set.

Once assembled, a workable and flowable concrete mix is placed into the forms (usually by pump) to create a solid insulated wall. Generally, the pour rate is slower than with conventional forms - in 2 to 6 foot lifts to avoid placing high pressures on the forms.

Below grade, a waterproof membrane is applied to the exterior surface

With no special tools or labour, a 2 or 3-person crew can erect walls from footing to roof in as little as a day. Crews become experienced after constructing three or four houses, and little time or material is wasted. Walls with a thermal resistance of about RSI 3.5 (R-20) can be assembled in a fraction of the time required for wood or steel construction. Because the forms are part of the finished structure, construction site waste is reduced substantially. Most contractors using ICF are carpenters who also build with frame.

Because of the insulation, concrete can be placed year-round, even in temperatures

Insulated Concrete forms
- *Easy to use*
- *No specialised labour or tools*
- *Combines framing, insulation, sheathing and air barrier into one easy step*
- *Superior R-values*
- *Clean and secure work site*
- *Reduced call backs*
- *Year-round construction*
- *Less construction waste*
- *Require more care in layout*
- *Less robust forms*
- *Requires small aggregate concrete mixes*
- *Slower pour rates.*

as low as -30°C (-22°F) so there is less need for special curing treatments.

Usually, hot and cold water pipes and electrical lines are easily placed in chases, by cutting or routing into the EPS. Electrical boxes are cut into the EPS and fastened to the concrete wall structure.

Expanded polystyrene forms will not fuel or spread a fire. If there is a fire, toxic emissions from the ICF forms are less hazardous than those from wood.

All popular exterior sidings can be used: from panel and lap siding to brick, stone, or stucco. Each system includes a nailing flange to which fasteners can be attached.

Insulating concrete forms generally costs about 5%-10% more than conventional wood frame construction. Although costs vary based on material and labour prices, volume of work, etc., an ICF exterior wall may cost $1.00 to $4.00 more per square foot of gross exterior wall area than that of a standard frame wall. The difference will be a bit less if comparable features are built into the frame wall.

A comparison between insulating form construction, R-2000 frame construction, and conventional wood frame construction shows that the initial costs for the ICF home to be a bit lower than R-2000 and a bit more than conventional wood. The Portland Cement Association forecasts that, with higher volume of use, the price difference should disappear.

A major concern is that, because the form work remains in place, any imperfections in the concrete are not exposed as they are with conventional forms.

Voids and excessive honeycombing are the major concerns building inspectors (and structural engineers) have about these systems. To ensure wall uniformity, the concrete must be consolidated by internal or external vibration. Internal vibration must be done carefully because the polystyrene cannot take the pressures and motion of careless concrete vibration. Too much pressure improperly applied can damage the insulation and lead to a blow out.

The concrete mix should not contain large aggregate (" minus rather than a conventional ¾" minus) and may need to be mixed for easy flow. Each manufacturer provides guidance on the appropriate mixes.

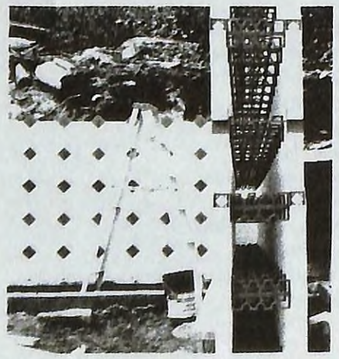
An important first step (that cannot be overstressed) is providing a smooth level working surface. This means extra attention must be given to the footings, which should be level, square, and wide enough to support the insulating forms. From this level starting point, the rest is relatively easy.

The building dimensions ideally will be related to the ICF modules, or a lot of trimming of forms may be needed, in which case much of the assembly time advantage may be lost.

Although manufacturers like to show how little bracing is needed, pouring does require caution. If there is not enough bracing, it is possible to distort a long wall section. In fact, it is possible to start with plumb and true walls and end up with a wavy wall.

Plank Type ICF Systems

These resemble conventional form work, in that the insulation planks and spacers are assembled on site. This means the materials delivered to the job site are more compact. They are also easier to modify to irregular dimensions than the block systems - an important factor for stepped foundations and highly articulated building designs.

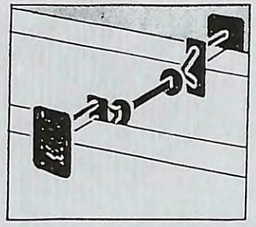


Diamond Snap-Form

The Diamond Snap-Form uses 1' x 8' panels of 2" thick EPS connected by a Diamond Snap-Tie™ every 12 inches, horizontally and vertically. The Diamond Snap-Tie creates a cavity for the concrete to achieve a nominal R-Value of 20 for the wall system.

Preformed factory cut 90° and 45° corner units are available. Concrete thickness available: 4, 6, 8 and 10".

Distributed by Plasti-Fab Ltd.
Tel: 1-888-446-5377
Fax: (604) 526-8519

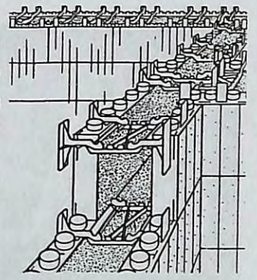


Lite-Form

The Lite-Form system uses all brand name extruded or two pound density bead board insulation, 2" thick. Local suppliers ship precut 8" wide foam planks notched at 8" intervals for the nylon ties. The nominal R-value will depend on the insulation board and can range from R16 to R20.

Spacer tie widths for concrete wall thickness of 4" to 24" in 2" increments are available. The square face of the ties is exposed for fastening of finish materials. Ties have alignment disks for easy installation of reinforcing bars.

Distributors cover regional markets.
Vancouver Island - Tel: (250) 748-2366
Ontario - Tel: 519-262-2924



Quad-Lock™

Interlocking 2¼" x 12" x 48" EPS panels notched for the Quad-ties that lock the system together. Ties are placed at regular 12" centres. The face of the ties is kept behind the face of the EPS, to provide a smooth surface. 4", 6", 8" or 10" nominal concrete wall thickness available.

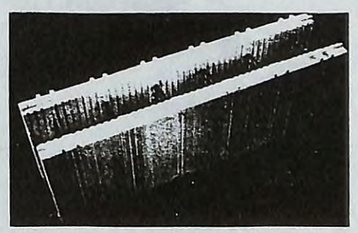
Quad-Lock Building Systems Ltd.
Tel: (604) 590-3111

Block Systems

These resemble large hollow masonry units. Most have interlocks that make them look like a giant's Lego blocks. Block systems require careful planning because making adjustments for irregular dimensions or angles may not be as straightforward as with panel type systems.

The shape of the concrete wall varies with the profile of the form interior. Some are essentially a flat wall, in others the concrete resembles a waffle grid, others yet are a post and beam. The interrupted grid and post and beam designs generally use the least amount of concrete.

Some of these systems are derivatives of earlier designs, or have evolved from a single design While they may be manufactured and distributed by different companies, they essentially are nearly identical products, with at most subtle design modifications.



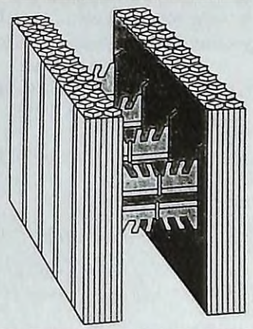
Advantage Wall systems

This is a prefabricated unit with an interlocking top and bottom profile that stacks together. Each unit has two panels of expanded polystyrene (EPS) held together by a high density plastic webbing spaced 8 inches on centre that can tolerate full internal vibration. The webbing provides a 1½" attachment surface for inside and outside finishes.

A 90° corner unit is also available.

The standard unit dimensions are 11¼" x 16½"x 48" (286 x 419 x 1219 mm)

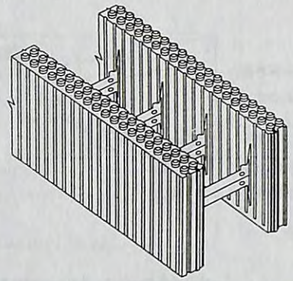
AAA Advantage Wallsystems Inc.
Tel: 1-800-881-5381 or (403) 678-6334



Blue Maxx Wallsystem
(also known as the AAB Building System)

Each standard Blue Maxx block is 11½" x 16¾" x 48" and consists of two panels of expanded polystyrene insulation, 2½" thick, held 6¼" or 8" apart by dense black plastic webbing spaced at 8" intervals. The webbing is designed to allow steel reinforcing rods to be snapped into place. Each web goes through the polystyrene insulation, ending in a vertical black strip spaced at 8" centres on the outside of the block to provide a fastening surface for the interior or exterior finishing materials.

AAB Building System Inc.
Tel: 1-800-293-3210



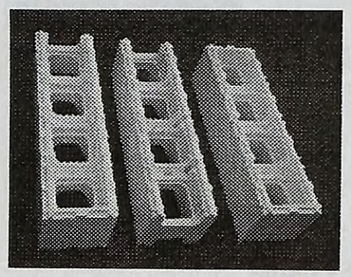
Greenblock

(CCMC 12069-R)

Greenblock units are modular, interlocking, blocks consisting of two EPS panels connected by a series of metal cross webs moulded into the polystyrene. The forms are dry-laid and stacked in a running (staggered) pattern. The laid-up units form a rectangular space which forms a concrete wall of uniform thickness.

External dimensions are 9 " x 9 " x 39 " (250 x 250 x 1000 mm).

Greenblock Co. Ltd. Tel: (719) 687-0645

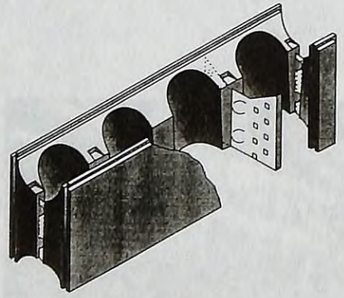


Envi-R-Form™

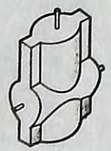
Also known as **Styroform** or **I-form**. This is a European designed block unit made of expanded polystyrene (EPS). Reinforcing steel is placed both horizontally and vertically as the form work installation progresses. External dimensions are 9 " x 9 " x 39 " (250 x 250 x 1000 mm).

Envir-R-Form Canada:	Tel: 403-278-4455
Styroform Building Blocks	Tel: 604-618-9114
International Form Building Systems	Tel: 604-448-8601

A number of systems are factory moulded insulation blocks composed of an inner and outer panel of closed cell EPS insulation joined with a steel or plastic connector that ensures a consistent cavity for the concrete. The wall formed is essentially a monolithic post & beam grid. The following are all individual customizations deriving from the same design.



ICE Block section (others have similar profile)



Typical concrete profile

Consulwal

(CCMC 12770-R)

Two moulded EPS panels are connected with a series of equally spaced metal webs moulded into the polystyrene. The forms are dry-laid and stacked in a running (staggered) pattern. The standard unit is 9" x 16" x 48" (230 x 405 x 1220 mm).

Consulwal Tel: 905-727-6176

EnerWall

The EnerWall system has 4" wide steel flanges (spaced 12" on centre) to provide a fire-resistant fastening surface for interior and exterior finishes. The standard unit is 9¼"x16"x 48".

Plasti-Fab Ltd. Tel: 1-888-446-5377

Ice Block

(CCMC 12646-R)

The ICE Block EPS panels are connected with galvanized steel brackets. The forms have tongue and groove edges to ease stacking and alignment. The standard unit is 11" or 9¼" wide, 16" x 48".

Builder Experts Inc. Tel: 403-273-4599

Polysteel

(CCMC 12638-R)

The EPS panels are connected with galvanized steel meshes. The forms are 9¼" or 11" x 16" x 48" (235 or 280 x 406 x 1219 mm)

American Polysteel Forms, 505-345-8153

Western Canada Distributor Tel: (250) 447-6465 or 1-800-667-4552

Insulating Concrete Forms for Residential Design and Construction

by Pieter A. VanderWerf, Stephen J. Feige, Paula Chammas, Lionel A. Lemay

This well illustrated book provides a detailed review of most ICF systems currently on the market in North America. Both Canadian and USA information is noted, especially as there are systems marketed in one country but not the other. Included is technical data and best practices data and many design details.

It is written to meet the needs of architects and engineers designing ICF houses, and provides excellent comparisons of features of the various systems. This is not the ultimate design guide, as that must reflect the specific properties of a given product. However, it is a good primer to the range of ICF products and gives insights on the entire concept of building houses in a new way.

Any builder, designer or building official wanting to find out more about this new construction system should look at this book, available from the Canadian Portland Cement Association. $84.00 plus GST.

Insulating Concrete Forms: Construction Manual

by Pieter A. VanderWerf and Keith Munsell

This is meant to be a step-by-step manual for insulating concrete forms (ICFs). It is a supplement to manufacturer manuals and a Portland Cement Association video. The authors relied on information from experienced builders throughout the USA. They also include take off and estimating worksheets.

Any builder considering using ICFs should review this is the book. For those without any practical experience, it offers number of valuable and commonsense pointers.

The authors point out that any house design that can be built with wood or steel can also be built using ICFs. In principle this is true, but the reality is not so simple. The simpler the house shape, the easier it is for ICFs. The plank type ICF systems that resemble conventional forms may be the most adaptable to a variety of designs. Some block type ICF systems are cumbersome to trim. Some complex articulated designs with many bays, jogs and cantilevers may not be suited for ICF systems.

One major oversight is that the importance of a level footing has not been stressed enough. A neat and level footing will make the assembly easy and trouble free.

Copies are available from the Canadian Portland Cement Association. $27.00 plus GST.

- ☞Basement walls must be damproofed, but the damproofing must be compatible with the foam, and this means it must be solvent free.
- ☞Concrete that flows better than in normal construction is required. This generally means a smaller aggregate size and possibly a plasticizer.
- ☞As a rule of thumb, there should be at least 16 inches of wall above and along either side of every door and window.
- ☞Because of the thicker walls, careful placement of doors and windows is necessary, otherwise they may not work properly.
- ☞In general, increasing the strength of the wall is accomplished by adding steel reinforcing.
- ☞A crew with one experienced carpenter and one concrete placer works well. Just as important, the crew should be interested and enthusiastic about the system.
- ☞The units must be set so that the vertical cavities are aligned precisely all the way up the wall.

The Portland Cement Association publishes many books, pamphlets, videos, CDs and software covering all aspects of concrete technology. If you are looking for information to solve a specific problem, or want to find out more about better ways to work with concrete, or even need some marketing literature for concrete related construction, get a copy of their catalogue from your regional office.

Canadian Portland Cement Association (phone):

Atlantic Provinces	902-423-7317
Quebec	514-739-2722
Ontario	416-449-3708
Western Canada	604-269-0582

Carpet Staining

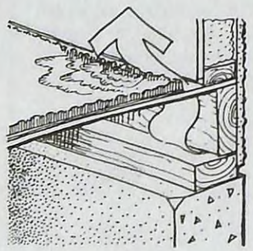
Carpet staining, found most commonly along the outer wall but also along some inner walls, is a problem that does not seem to be going away. The popularity of light-coloured carpets has made the problem worse because it makes the stains more visible. The problem is compounded by the fact that the stains are nearly impossible to remove. We cannot insist that everyone use dark-coloured carpets on the assumption that if you cannot see it, it is not a problem.

The stains are causing builders and warranty programs much concern, but there is no certainty about who is liable for the problem. Suggestions have been made that code requirements for sealing the building envelope have altered the air flow patterns in the house, resulting in the carpet fibers acting as filters to airborne contaminants. Polluted urban environments contribute to the problem, but fundamentally they are not the cause.

What is causing the problem, and how can we avoid it?

The physics are that fine dust and dirt particles are being deposited on the carpet at air leakage points. Air leakage is driven by pressure differences from one part of the house to another or from outside to inside. Air always moves from positively pressurized areas to those under negative pressure. If the area under negative pressure is polluted, the pollutant will be carried and deposited on the carpet in the area with a lower pressure through any narrowe gaps linking the two spaces. The air flow slows as it enters the larger space, so any particles contained in the air are deposited. At concentrated air leakge points the staining is accentuated.

The pressure differences can be caused by stack effect, or most commonly in houses with forced warm air heating systems, by the leakage of air from leaky ducts. Forced warm air systems are a major culprit because the ducts in the basement or crawl space can pressurize the space compared with the rest of the house. The ducts are usually not sealed and 30% to 40% air leakage is common, so this air leakage effectively pressurizes the crawl space or basement. Dust particles in the air are pushed through leakage points into other parts of the house, usually around partitions.



Stains can also be seen on the second floor, especially when you have a roof space next to an upper floor wall. The air passing under the wall plates moves exterior air inward, staining the carpets. Air can also leak at the rim joist and then enter at interior walls. Infiltration leakage will occur anywhere below the neutral pressure plain - typically near the middle of the house.

Lifestyles and candle use

Lifestyles may also be contributing to carpet staining. The emissions and soot particles produced by scented candles are becoming a more frequent problem. In the USA, some builders and heating companies have been the target of litigation or pending civil action as a direct result of soot deposition from candles.

The soot can not only damage a home, its contents, and the ventilation system, but also presents a health hazard. The cause of the soot is due to new formulations used in some candles, which have greater quantities of fragrant oils (some of which are not even suitable for combustion) and long wicks.

Unfortunately, once staining becomes noticeable it is often too late to prevent much of the property damage. A two or three thousand dollar cleanup bill can result from the use of as few as six candles for a single dinner party. There have been cases where the cleanup cost is in the $20 -30,000 range!☼

How can staining be avoided?

Much work remains to be done to identify solutions, and each house has its unique circumstances. However, here are some suggestions to reduce the problem.

- ☞ Heated crawl spaces should have a relief vent to keep them in a negative pressure in relation to the rest of the house. The balance of the house should be kept at an even pressure.
- ☞ Ducts should be sealed, especially if they run in a crawl space or basement.
- ☞ Penetrations in the envelope should be air sealed.
- ☞ Air sealing of the house should be done carefully.
- ☞ Lifestyle practices may have to be modified (especially the use of inappropriate candles).

The Model Energy Code offers flexibility

Nine out of ten home buyers are looking for energy efficiency. Compliance with the Energy Code gives it to them.

The Model National Energy Code for houses is a set of guidelines to ensure that new homes and large additions meet minimum standards for energy-efficiency. While some people may think this simply means adding more insulation, the model code offers more flexibility to the designer.

The Energy Code looks at five major systems: the building envelope; lighting; heating, ventilation and air conditioning; domestic hot water heating; and electrical power requirements. Most home builders will simply use the recommended minimum values for their area and the energy source that will be used to heat the house.

Some consider the Model Energy Code is an application of R-2000 to all housing. However, the energy performance target is not as stringent as R-2000. It merely sets out minimums that are cost effective and that, in general, will raise the energy efficiency of all housing stock. Going beyond, the minimums, or to R-2000 higher standard is still encouraged.

"I followed the Energy Code and didn't have any problems with it," said John Coppens of Guildcrest Homes in Ottawa. "We are probably building above the code anyway. We might have to upgrade a standard spec slightly to fit a different zone."

The designer can ensure each individual component complies or, optionally, ensure the overall design meets the Energy Code energy-efficiency target for the house. Using this house-as-a-system approach gives flexibility to the consumer and builder.

If your customer wants to use his basement as a home office, you will want to add more insulation in the basement to increase the comfort level. You can do that now but it will cost extra. With the Energy Code, you can add that insulation and offset the increased cost somewhere else, as the code is only concerned that the entire house meets the overall energy target. It is this "trade-off" feature that makes the Energy Code both consumer and builder-friendly.

The trade-off can be calculated manually, but it is much easier with a new computer program called HOUSTRAD. With HOUSTRAD, you simply make your choice from lists of different standard construction assemblies, or create your own detail. The program calculates if the exterior envelope complies with the Energy Code.

HOUSTRAD eliminates searching through the Code to find minimum insulation values. It makes it easy to check out different construction options, especially now that we are moving toward using effective thermal resistance instead of nominal insulation values for walls and attics. You can try out different combinations of stud materials, spacing and insulation nominal R-values, and HOUSTRAD calculates the effective R-value of the assembly. It makes comparing envelope design to the Code relatively painless.

The volunteers from industry and government who put together the Energy Code had a mandate to ensure the Code would be effective without being complicated, expensive or inflexible. It breaks the country into 34 different regions, each with an individual set of standards adjusted to area energy prices, construction costs, and climate. As a result, incremental construction costs are offset by energy savings and the energy efficiency is cost effective for the home buyer.

The Energy Code is not something radical that has not been done before. It responds to many concerns raised by the industry.

Home buyers are increasingly concerned with more than simply the appearance of their homes. They worry about how the house operates, its comfort level and energy costs. With the Model National Energy Code for Houses builders can show consumers that their homes will provide comfort and affordability by complying.☼

R-2000™

For information on the R-2000 Program, contact your local program office, or call 1-800-387-2000

How the Energy Code can help sell houses:

It means greater comfort for no increase in ownership cost

- consumers are demanding energy-efficient housing
- energy-efficiency does not cost any more as the increased monthly mortgage is offset by the lower monthly energy bills.
- it gives consumers a reference point to measure energy efficiency: if it is not as efficient as the minimum standard, it is not an energy efficient home.
- rooms in the house are heated evenly
- the tighter envelope means no drafts
- they are helping Canada reduce its CO_2 emissions

Letters to the Editor

I would like to follow up your editorial in the May issue of Solplan Review, concerning to the research done in housing.

I was part of the committee that designed and built the MARK IX research house in 1972 in Regina. It was the ninth in a series of research houses. It was not intended at the outset, but I ended up owning the house and lived in it for 24 years.

Among the research elements were the first steel-walled basement in North America, steel floor joists, exterior load-bearing studs and interior non load-bearing studs. In addition we placed the furnace on the roof, exterior wall insulation with acrylic stucco and sundry other projects.

When the construction was completed, I found everyone involved including the technical research people of the Home Builders' Association declaring the project complete. I tried to remind them that the project had just started. I worked with the NRC people for at least ten years in the gathering of information and they did a fine job.

On two or three occasions I wrote the association to ask if they wanted to do an updated report on all of the research elements of the house while most of the people involved were still available.

I believe there were twelve mark projects in total. However, are there any reports available as a result of some major expenditures? If not why not?

Three years ago we moved into another all-steel house that was not a research house although we have tried a few new ideas. We have just finished repainting the upper level because of ghosting problems. This came to mind when I read your piece on unvented gas fireplaces. We are working with the Saskatchewan Research Council to get a fix on the cause.

As you might surmise, my concern is for research done that lies on shelves.

Ken Sexton
Regina, SK

Thanks for your comments. It is true that research is a means, not an end. We must take advantage of all opportunities available to collect long term data. Short term data is also valid, and not to be dismissed, as the lessons learnt in construction by themselves are important.

You bring up a valid point, and that is the importance of long term data gathering and analysis. The major problem is one of adequate resources. The MARK houses were the result of collaboration between the National Research Council (Division of Building Research), CMHC and HUDAC (now CHBA).

The bigger problem is one of how to transfer the information to those that can take advantage of it. Every few years there is, in effect, a new generation of participants in the industry who may not be aware of all the information and resources available.

CMHC produced a publication titled "50 Years of Housing Innovation" to highlight the wide range of construction research and innovation in Canada in the recent past. While not particularly scientific, it did offer an overview of activities. Detailed reports are always accessible through CMHC's Canadian Housing Information Centre (CHIC). Other libraries and agencies throughout the country also have many of the publications, as does, increasingly, the Internet. However, the big problem is to get individuals to use the information. Ed.

RE: Solplan Review May 1998 - Fire Resistance of Gypsum Board Wall Assemblies

You missed the mark in your item on gypsum board wall assemblies.

1) It is true that when the CSA standard for gypsum board was revised in 1991, the requirement for minimum density of gypsum board was removed, but it applies only to regular gypsum board, NOT Type X and the majority of this article deals with Type X gypsum board. The changes to CAN/CSA-A82.27 had NO effect on the mass of Type X gypsum board.

2) The article deals with the results of small-scale fire test assembles. The same test program included full-scale (meeting CAN/ULC-S101) fire tests. A discussion of these results would have been much more useful. The small-scale tests were done for informational and analytical purposes and should not be referenced for practical building purposes.

3) The end result of this research (the full-scale tests) was a significant expansion to the fire ratings provided in the appendix to Part 9 of the NBCC-1995 in Table A-9.10.3.1.A. This table of fire (and sound) ratings was expanded to approximately 150 wood and steel stud wall assemblies. For the builder this is the bottom line, this is the useable (practical!) result of this research. Reference to Table A-9.10.3.1.A of the NBCC-1995 and should have been included.

Brad Wing, Westroc Industries
Mississauga, ON

Leaky Condo Follow Up

Last issue (Solplan Review, July 1998) we featured a review of the situation concerning building envelope failures presently unfolding in BC.

The Barrett Commission of enquiry into the quality of construction has released their report. As we pointed out, there is no single guilty party, but rather a breakdown of the entire development process. Tellingly, the title they put on the report is **The Renewal of Trust in Residential Construction.**

The report surprised some in the industry. There had been a concern that because an ex-premier was the chair of the hearings, he would prepare a partisan political document to protect politicians, deliver a politically charged document placing blame on perceived enemies and encourage the entry of unions into the residential construction sector. The report, however, is a neutral document with 82 recommendations touching all sectors of the industry, and scolding many, including professionals. Many recommendations may not be carried out, but their impact will be felt by everyone in the industry.

The Commission points out that a system works only when people are willing to do whatever is required to maintain its integrity. "Entrepreneurial freedom - an important element in innovation, economic growth, and prosperity - carries with it an implied responsibility and trust that the entrepreneur will pursue continuous improvement in skills and ability, as well as maintain a code of ethics, regardless of the effectiveness or ineffectiveness, of the existing rules and regulations. Entrepreneurial freedom should not run the risk of becoming a euphemism for con-artistry. There is always an ongoing interaction between the system and the people who operate within it."

The Commission's report also notes that financial institutions showed no desire to participate in a meaningful way in the public hearings.

... by early 1999 ... all construction activity in British Columbia will only be carried out by licensed contractors ...

A key recommendation that has been accepted is that an independent Homeowner Protection Office be established. This office will have three main functions:

i) a regulatory arm, to license all residential contractors and subcontractors within the province. This will address the consensus that the industry requires a registry of qualified developers, builders, contractors and management firms for condominium buildings.

ii) a research and education arm to carry out research and education respecting residential construction in British Columbia.

iii) administration of the program.

The intent is that by early 1999 procedures will be in place so that all construction activity in British Columbia will be carried out only by licensed contractors.

A mandatory private, third party new home warranty will be required to cover all residential housing built, including units undergoing renovations for structural and building envelope purposes.

It was clear to the Commission that the current owners of leaking buildings require assistance and support in dealing with a catastrophic situation. As a result, they recommended that a Reconstruction Fund for homeowners be established to provide financial resources to those most adversely affected by problem buildings. ☼

The full report of the Barrett Commission has been posted on the Internet at: http://www.marh.gov.bc.ca/

Coming Events

August 22-23, 1998
EarthFEST, Courtenay, BC
A fun event to bring people together and provide them with enthusiasm, ideas and tools to live more sustainably on the planet. Themes & technologies & methods to be demonstrated:
F = Food E = Energy S = Shelter T =Transportation + Water
Information:
Tel: 250- 537-2616 Fax: 250- 537-2681
e-mail: earthfest@saltspring.com

Sept. 7 - 10, 1998
Circumpolar Housing Forum '98
Yellowknife, NT
Tel: 1-888-683-7711 or (604) 530 - 3840
http://nwthc.gov.nt.ca
www.northernforum.org

October 16-17, 1998
NEX'98 North American plumbing, heating & cooling trade show
Toronto, ON
Tel: 416-695-0447
Fax: 416-695-0450
e-mail: ciph@ican.net

October 26-28, 1998
Green Building Challenge '98
Vancouver, BC
Tel: 613-943-2259
Fax: 613-996-9909
http://greenbuilding.ca

October 28-31, 1998
Excellence in Building Conference
1998 EEBA conference
Washington, DC
Tel: 612-851-9940
Fax: 612-851-9507
http://www.eeba.org

April 19-24, 1999
Affordable Comfort
Chicago, IL
Tel: 724-852-3085
Fax: 724-852-3086

Sustainability and the Building Codes

by David Eisenberg

Building codes are based on a need to protect the health and safety of people from the built environment. If, however, the codes actually jeopardize the health and safety of everyone on the planet by ignoring the impact on resources and the environment, which indirectly lead to the destruction of the natural systems we depend on for our survival, then we have to rethink our approach to codes.

Until now, the building codes have been created and enforced almost completely ignoring the enormous secondary impacts they have on the environment, our economy, and our society. Buildings consume about 40% of the materials and resources entering the global economy each year, and building codes influence virtually every aspect of building design and construction.

If we think about buildings in terms of what they do, rather than what they are, we can begin to see the problem in its larger context. Performance-based building codes describe what buildings must do, in terms of structural performance and other criteria for safety. We could also think about what buildings should not do: buildings need to do no harm.

To think about the harm buildings can do, we need to start with the consequences of the resources used:

- the transportation and processing of raw materials into usable components and equipment along with the production of wastes and toxins as a result the transportation of the manufactured goods;
- the assembly of those components into the building itself; the effect of the building as it sits on and alters the land;
- the flow of resources needed to maintain the building through its lifespan, both to maintain the structure and to provide the comfort and services for the occupants;
- the effects of the modifications that might be made to the structure during its life;
- and finally the consequences of the eventual demolition and disposal or reuse of the materials that make up the building.

The only part that codes deal with is that buildings do no harm to their occupants or to other people or buildings in their immediate vicinity.

The code development process focuses on the safety of people in buildings at the expense of the larger consequences. It discourages lower-impact construction methods because these are often less industrial and technologically based. This happens because of the widely held belief that higher technology is always better and that the highest level of available technology should always be used.

Another problem is that we think about buildings as individual projects. We design buildings and building codes, and enforce those codes thinking one building at a time. In fact we are building millions of buildings. A decision made on the scale of one, but repeated millions of times, can have serious consequences.

As William Rees and Mathis Wackernagel, at UBC in their ecological footprint idea (Solplan Review No. 57, July 1994) have shown, if everyone on earth were to consume resources and generate waste at the way the average North American does, we would need two more planet Earths to sustain that level of activity. Because such a large part of the resource use and waste generation is related to buildings, we need to make our buildings far more resource and energy-efficient to have any hope of sustaining reasonably hospitable conditions on earth. That means building codes must accommodate significant changes in the way buildings are designed and built.

We must learn to integrate into the design, building, and regulatory processes a comprehensive awareness of the real impact of our decisions. We may not understand all of the consequences, but we cannot ignore the enormous complexity of the impact of decisions. We can admit that we do not know all the answers and begin to make our decisions on the intent of reducing the level of unintended consequences of our actions.

Appropriate technology can be defined as the lowest level of technology that will do well what needs to be done, as opposed to our cultural bias for using the highest level of technology that we think we can afford. Building codes have continuously evolved toward the use of higher levels of technology, and almost exclusively, industrially processed materials.

Building codes ignore the environmental impacts of material use. They ignore where the resources come from, how efficiently they are used, or whether they can be reused at the end of the useful life of a structure.

Why is this important? Buildings account for 25% of the world's wood harvest, 40% of its material and energy usage, 16% of its fresh water usage. In the past 100 years the amount of carbon dioxide in the atmosphere has increased 27%, one quarter of which has come from burning fossil fuels just to provide energy for buildings. During the same period, the world lost 20% of its forests.

If you apply the resource intensity required by North American building codes to the world, it becomes apparent that, with the available resources, housing that number of people in this manner is not even remotely possible. Yet we are in the process of developing building codes based on our resource intensive way of building and promoting these codes worldwide.

There is a long history of battles between the building regulations and proponents of both traditional and improved low-cost, low-tech, and low-impact building systems. This is often in the shadow of indigenous buildings that are hundreds and even thousands of years old. How did the indigenous, natural or low-tech materials and building systems, which have been used for thousands of years, get moved to the status of "alternative" materials and methods? In many climates, the indigenous buildings are far more comfortable and have far fewer negative impacts and costs than the modern buildings that have replaced them.

Our bias makes it difficult to accept that we can learn from "primitive" building systems, though many were brilliant examples of appropriate technology. The lack of a larger vision in code development has allowed this "mismanagement" of resources to pass unnoticed and unquestioned for decades.

The issues of sustainable building extend beyond these resource-based problems. They include the toxicity of the processes through which materials are extracted, manufactured and used. Only recently have the health effects of buildings themselves, rather than their failures from fire or structural flaws, been recognized. The economic, social, and cultural impact of these health issues are also profound yet not considered.

All buildings are treated as though they need almost the same level of technological sophistication, whatever their use, location, owner preference, cost, or impact. Variations in existing code standards for different types of occupancy are relatively minor.

If we truly believe that the preservation of health and safety is the real and legitimate purpose of building codes, then we must deal with these larger issues. Should the safety of the individuals in specific buildings be more important than the well-being of all of us, including the other things that make up our ecological life support system on this planet?

We should not ignore the fact that modern building codes were initially developed by insurance interests and have been influenced heavily by the industries that produce the materials and building systems regulated by the codes. We also must recognize that the insurance industry around the world is taking the threat of global warming seriously as it relates to their exposure to risk.

We have to develop a process to assess codes based on whether they really preserve or threaten health and safety - whose, where, and at what levels. We must create a different kind of wisdom about building design and regulation based on seeking an understanding of local and global outcomes. This is an enormously challenging idea and a large task. What needs to change is actually less in the codes than in the minds of the people who write, enforce and use them.

Some changes may already be taking place. One such change is the shift toward performance-based codes.

A debate about the overall issues is much needed. The development and increased adoption of model energy codes is encouraging. These codes represent the first step toward codes that are not strictly based on the narrow definition of health and safety. They exist because of the larger societal context that is absent elsewhere in the codes. Model energy codes are there to preserve health and welfare on a community level. The Development Centre for Appropriate Technology in Tucson, Arizona is trying to foster support for research, testing, and development of low-impact building materials and systems, to bring them into more common and practical usage within building codes. Since these materials and systems often lack a developed "industry" or profit base for their development and promotion, they cannot attract the type of investment that proprietary materials and systems do, to pay for extensive research and testing. Changing the way buildings are designed and built starts with an awareness of the complexity of the relationships and impacts of what we do. While the challenges are of monumental proportions, we are not starting from zero in this endeavour. ☼

This article is based on a paper presented at the BETEC (Building Environment and Thermal Envelope Council) Emerging Technologies Symposium - Sustainable Building Envelope Materials, November 19, 1997 in Washington, D.C. David Eisenberg is Co-Director of the Development Center for Appropriate Technology in Tucson, Arizona. He is coauthor of The Straw Bale House book, and many articles and papers on this and related subjects.

Technical Research Committee News

Canadian Home Builders' Association

Drinking Water Materials Safety Act

The Canadian Water Quality Association, an organization representing the water supply industry is raising the alarm that Bill C-14, the Drinking Water Materials Act currently before the House of Commons, could affect every piece of equipment or material related to drinking water in Canada. This would mean increased material costs for water system components.

Bill C-14 is legislation that tries to mandate quality control and would require third party quality assurance for all of components of the potable water system. The public will be misled into believing that the Bill offers significant improvement in potable water quality when, in fact, it does no such thing. The legislation in effect proposes guidelines that have no force of law.

It is not entirely clear what the motivation is behind this bill. Problems with the safety of drinking water in Canada derive from the quality of source waters, and the way in which water is collected, stored, treated and delivered as drinking water and not with the components. If there are problems with devices or components today, they can be handled under existing legislation. An example is the way lead-containing solder was prohibited in potable water systems by plumbing codes.

Many of the Drinking Water Materials issues raised as potential sources of risk to consumers are not considered to pose actual health risks. The TRC is monitoring the situation.

Furnace Filter Study

A CMHC study now underway is looking at common types of filtration. Preliminary findings show that the total dust concentration in the air varies over a day. Generally, in mid afternoon (when occupants have been away for some time) and during the sleeping hours the concentrations of dust are around 4 to 5 micrograms per cubic metre. In the family room, once the family arrives home, the concentration of the dust increases 4-5 times, up to 25 micrograms per cubic metre.

The high efficiency filters being studied are very effective at removing dust if the dust gets into the filter. Dust that is 10 microns in size and smaller (these are the particles you can see in the sunlight) essentially sinks into the carpets, drapes and furniture and is not getting to the furnace filter. It appears that to remove the smaller dust particles, continuous operation of the furnace fan is required for very high efficiency filtration to have an effect.

Vapour Diffusion and Air Movement

Vapour diffusion and air movement through building envelope components is often misunderstood and often creates construction detailing problems. Vapour diffusion is the moisture transfer through the pores of materials. Designers and codes concentrate on the outward wintertime diffusion. However, it is accepted that diffusion is less important than air leakage. Most of the condensation problems in building assemblies are caused by air exfiltration, which air barriers are intended to resist.

Before the 1990 edition of the Building Code, vapour barriers were intended to do what we now recognize as *air barrier* functions. The 1990 edition explicitly dealt with air barriers and introduced the idea that the vapour barrier and air barrier functions could be served by different materials or combinations of materials is the same building assembly.

Vapour diffusion, which vapour barriers are intended to resist, is a much weaker mechanism that can easily be controlled by even the limited vapour resistance of many types of paint film. The forces of vapour diffusion are often misunderstood, and have received much scrutiny lately, especially in the analysis of the building envelope failures on the West Coast.

Vapour flow can go in both directions in some climate conditions. Solar heating of a wet wall surface can drive water vapour into the building assembly. This means that in summer, the south side exposed walls could have problems in some conditions. The moisture source will be water from driving rain, rain penetration, or in new construction, built-in construction moisture. Inward diffusion problems can arise in construction assemblies that could store moisture in exterior layers, or that use vapour permeable materials in the wall construction.

Summertime inward vapour pressure drives can be 2 to 4 times larger than outward winter drives, but are of short duration. However, condensation is critical in warm weather because conditions are ideal for corrosion and fungal growth. The increased use of air conditioning in homes increases problem because the interior surface temperatures are lower. This means that the design of building envelopes must balance winter drying to the exterior with summer wetting and drying to the interior.

Suggestions have been made that walls be built without any poly, to allow vapour to flow through and dry the wall, especially in the mild west coast climate. This may be appropriate for diffusion of vapour, but it would still not deal with moisture problems due to leakage of rain from the exterior. It is also important to remember that vapour resistant interior finishes, such as paints, vinyl wallpaper and many wood panel products also restrict vapour movement and contribute vapour resistance. This points to the need to consider options other than polyethylene for vapour barriers.

When polyethylene is used for both air barrier *and* vapour diffusion functions, it must conform to the CGSB standard for polyethylene (CAN/CGSB-51.34) which requires a minimum 6 mil thickness and UV resistance. The standard mostly addresses properties that are important when the polyethylene is used as an *air barrier* but less so when it is used as *vapour barrier*. For example, resistance to tearing is important for air barriers since tears in an air barrier should be avoided but a few holes in a vapour barrier are not very serious.

When polyethylene is only used to perform the *vapour barrier* function, and not the air barrier function, it need not comply with the standard. That is why the new edition of the National Building Code no longer requires 6 mil poly for *vapour barriers* alone.

Proper building envelope design should still provide control from the elements, keeping the outer layers of the cladding dry, reduce vapour transport inwards (e.g., by using heavy building paper, extruded polystyrene insulation, etc.), and

The Technical Research Committee (TRC) is the industry's forum for the exchange of information on research and development in the housing sector.
Canadian Home Builders' Association,
Suite 500, 150 Laurier Ave. West, Ottawa, Ont K1P 5J4
Tel: (613) 230-3060
Fax: (613) 232-8214
e-mail: chba@chba.ca
http://www.chba.ca

Toilet Problems?

Low flush toilets were introduced several years ago in response to a need to introduce water conservation. Early models did not always get adequate engineering and had some problems. We keep hearing rumours that some models, in some situations, may be a problem.

Now that the low flush toilets have been in use for some time, there should be field experience to know how often there are problems, and what the nature of the problem may be.

If you have encountered any problems with the low flush toilets, let us know.

Reinforced Plastic Wood

The problem of waste plastic worldwide is growing more quickly than methods are being found to dispose of or use it. In North America and Western Europe plastics have continued to be an increasing portion of the waste stream, as only 4% is recovered for recycling. Due to its low density, plastics make up 24% by volume of the solid waste disposed into landfills.

One challenge for plastic recycling is the wide variety of product composition. One product application for recycled plastic is "plastic wood" which has a small niche market mostly for landscape applications. However, the major problem with plastic wood is that it is not structural, and deforms when heated on a sunny day. As a result, plastic lumber decking materials cannot offer the guaranteed structural properties required by engineers and architects.

An Edmonton company, EcoTrust Technologies Inc. has developed a way of reinforcing plastic lumber using roll formed steel reinforcement encapsulated in the plastic composite material. They have developed 2" x 4" and 2" x 6" modular structural components for decking, joists, beams and posts and will be marketing it under the name "EcoSteel." The product can be cut on-site and fastened by screws or clamps.

It seems like a good replacement for conventional treated products used on outdoor decks, marinas and docks, boardwalks, walkways, and stairs.

Information:
EcoTrust Technologies Inc.
Edmonton, AB
Tel: (403) 448-1007
Fax: (403) 451-9382

Energy Answers

Rob Dumont

What is Canada's target to meet the Kyoto protocol regarding climate change?

Canada has tentatively agreed to reduce its greenhouse gas emissions by 6 percent compared with 1990 by the year 2008-2012. However, 55 countries must sign on before the protocol becomes binding.

To meet this target, given that energy consumption has risen in Canada almost every year since the industrial revolution, will take the equivalent of a domestic Marshall Plan. Already, Canada's energy consumption is up about 13% from 1990.

Are there gases other than carbon dioxide that contribute to global warming?

Carbon dioxide is responsible for about 72%; methane is responsible for 20%, and nitrous oxide for the remaining 8%.

If Canada does little or nothing to limit energy consumption, as happened with our commitment made in Rio de Janeiro in 1990, what will Canada's consumption be in 2008-2012 using a "business as usual" scenario?

The projection is that Canada will be producing 27% more greenhouse gasses in 2008-2012 compared with 1990 if "business as usual" continues.

What is the biggest cause of increased energy consumption in Canada? Is it population increases, more consumption of goods, or something else?

Some years ago the Ehrlichs (best known for the book The Population Bomb) presented a simple equation to describe the impact of human beings on the planet:

I = P x A x T

where:

I *= adverse* ***Impact*** *on the environment caused by people and their activities*

P *= number of* ***People***

A *=* ***Amount*** *of consumption per person*

T *=* ***Technology*** *factor (amount of pollution per unit of consumption)*

To stabilize the **I** factor, all three factors on the right-hand side of the equation must be controlled.

In Canada, the **P**opulation factor has been growing rapidly. From 1941 to 1991, the population of Canada more than doubled (from 11.5 million to 27.3 million, an increase of 137%).

The **A** factor, which deals with consumption, is harder to track, as the statisticians do not count things that way. The Gross National Product (which counts the value of all the goods and services) increased in real dollars from $6,300 per capita in 1941 to $20,500 per capita in 1991, or 225%. The **A** factor increase of 225% is much greater than the population increase at 137% over the half-century.

The **T** or technology factor is also hard to quantify. The efficiency of many technologies has improved. Some cars, trucks, houses and industries are more fuel-efficient, but many other energy users like coal-fired electricity plants (about 30% efficient) are not much better than older units. In addition, the popularity of trucks, sport-utility vehicles, and mini-vans, all of which are exempt from fuel economy regulations, has negatively affected the efficiency of the transport sector. A September 1990 Scientific American article estimated that over the half-century interval from 1940 to 1990, the energy use per dollar of gross domestic product in the U.S. had fallen about 50%. Thus, only the **T** factor, or pollution per unit consumption, is headed in the right direction.

An interesting characteristic of the **IPAT** equation is that the three terms on the right hand side of the equation - population, consumption, and pollution per unit consumption - must all be limited in a finite world. With population and consumption still rising in the world, the efficiency factor, or Technology factor, is being called upon to do a gargantuan task. To use a rowboat analogy, two oars are heading toward the falls; but only one is pulling in the opposite direction.

How is energy used in Canada?

The three main uses for energy in Canada are **buildings, transportation, and industry.** In rough terms, about 1/3 of the energy is used in each of these three categories.

What are the big energy users in the building sector?

The three big energy users in houses and small buildings are space heating, water heating and appliances. In large buildings, space heating, ventilation and lighting are the big users. Any programs that are Kyoto-serious will have to address these end uses in a serious way.

What are some key measures you would advocate for improving energy use in the building sector?

The French philosopher Montaigne once wrote "No wind blows in favour of a ship that lacks a destination." Our energy destination has to be a very energy efficient society powered by renewable energy sources. Here are some policy ideas I believe could start us on the path:

Rob Dumont's column suggests some measures to help Canada meet the Kyoto target. Solplan Review's readers are invited to send their comments on other steps that can be taken. You should include the reasons for your suggestions.

You can send comments to Solplan Review, or directly to Rob Dumont. Rob can be contacted by e-mail: at dumont@src.sk.ca or fax at 306-933-6431.

1. Begin a major educational program to inform Canada about the risks of global warming.

"Educate or evaporate" might be a good slogan for the campaign. Many Hollywood films have a marketing budget that is bigger than the cost of making the film. Education is expensive, but vital.

2. Offer low-interest high-ratio mortgages only for old or new dwellings that meet a minimum efficiency standard. Allow the incremental cost to upgrade the dwelling to be amortized on the mortgage.

For new houses, the R2000 performance standard could be used initially, followed later by a standard closer to the Advanced Houses criteria. For existing houses, a revised R2000 retrofit standard for minimum energy efficiency could be developed. Canada now has a good understanding residential energy consumption in various locations and of varying ages, and could rapidly develop a retrofit standard. The new Energuide for Houses program could be used to rate the houses. The more efficient houses would have lower utility costs, and thus the owners would be less likely to default on mortgage payments.

3. For commercial and institutional buildings, offer a similar low-interest mortgage or loan program targeted to upgraded buildings.

Again, relatively good data is available on the energy consumption of commercial and institutional buildings. The federal government has the Commercial Buildings Incentive Program in place for new commercial buildings designed to be at least 25% more efficient than a building that complies with the Model National Energy Code for Buildings, but the benefits are capped at $80,000 per project and only apply to new buildings.

For all buildings, make low-interest loans available to be used exclusively for upgrading energy efficiency.

4. Continue the successful energy demonstration programs such as the C-2000 and Advanced Houses Programs, but with enhanced funding. Renewable energy sources must also be given sustained R & D funding.

A buildings program without an innovative research element is like an airplane with only one wing - it is cheaper, but it will not fly. Renewable energy sources, such as solar thermal, photovoltaics (solar electricity), biomass, wind and small hydro have all made good progress in recent years. Sustained funding for research and development is vital. A sustainable world will not be without sustainable energy sources.

The following recommendations are equipment specific:

5. Mandate a minimum 90% efficiency for all new gas fired furnaces.

The present standard only requires a minimum annual fuel use efficiency of 78%.

6. Ban all pilot lights in new water heaters.

Most gas water heaters sold in this country use pilot lights. Each burns and waste about 8 million Btus per year. Pilot lights were phased out successfully on new gas dryers. Also increase the minimum insulation factor on water heaters to R-20 (RSI 3.5). Most existing gas water heaters have annual efficiency values less than about 60%.

7. Ban electric resistance water heaters.

Exhaust air heat pump water heaters that can substitute for electric resistance water heaters are now available and can provide inexpensive hot water and ventilation air. This measure would also discourage people from using an electric water heater instead of a gas water heater.

8. Mandate the use of windows that have at least the equivalent of double glazing, argon gas fill, low e coating, and low conductivity spacers.

This would apply to both new and replacement windows. Manitoba ran a very effective incentive program that encouraged people to use more efficient windows; as a result the market started to supply only triple glazed windows.

9. Upgrade the minimum energy efficiency standards for appliances.

Refrigerators, freezers and clothes washers can all be significantly improved. A front loading washing machine uses less than 50% the energy a top-loading model does. Frigidaire makes a front loading machine with an Energuide rating of 264 kWhr per year while similar sized top-loading machines are rated at more than 640 kWhr per year.

10. Raise taxes on energy to pay for the above programs.

No one likes to pay taxes, but the vast majority of citizens, when informed about the problem of greenhouse gases, will go along with taxes. Many Europeans, for instance, pay as much as $1.50 per litre for gasoline while in most of Canada prices are less than $0.60 a litre (less than bottled water!). Is it any wonder that so many people in Canada buy minivans and sport-utes when gasoline is so cheap? The demand for energy, like all commodities, is elastic over time; raise the price and people will conserve. ☼

Details about the Commerical Buildings Incentive plan and Model Energy Codes can be obtained from NRCan at Fax 613-943-1590; or e-mail cbip.pebc@nrcan.gc.ca)

NRC·CNRC

Fire Resistance of Floor Assemblies Protected With Gypsum Board

By Mohamed A. Sultan

The National Research Council of Canada (NRC), in collaboration with industry and government partners, recently carried out an extensive research program to measure the acoustic and fire performance of floor assemblies. The objectives of this research were to confirm existing fire resistance and acoustic ratings in the current (1995) version of the National Building Code of Canada and to provide reliable information to help construction practitioners to develop cost-effective and innovative floor assemblies.

The elements investigated in the fire-resistance aspect of the study included: the sub-floor; gypsum board screw spacing from board edges; wood-I-joist type; method of fastening the gypsum board butt ends; insulation type; number of gypsum board layers, joist spacing; resilient channel spacing; addition of a concrete topping and structural load.

Results

Effect of subfloor type: The type of subfloor (oriented strand board and plywood) did not affect the fire resistance of the assembly.

Effect of gypsum board screw spacing from board edges: An assembly with screws 38 mm (1½") from the gypsum board edges provided a significant increase in fire resistance compared with an assembly with screws 10 mm from the gypsum board edges.

Effect of wood-I-joist type: For non-insulated wood-I-joist assemblies, the joist flange type and size affected the fire resistance of the assembly. An assembly with flanges 64 mm (2½") wide by 38 mm (1½") deep provided 16% more fire resistance than an assembly with flanges 38 mm (1½") wide by 38 mm (1½") deep, and 8% more than an assembly with flanges 38 mm (1½") wide by 64 mm (2½") deep.

Effect of method of fastening the gypsum board face layer butt ends: The method of fastening the gypsum board face layer butt ends to the resilient channels in wood-I-joist assemblies with two layers of gypsum board affected the fire resistance. An assembly with Type G screws used to fasten the face layer to the base layer at the butt ends provided 7% more fire resistance than an assembly with steel screws used to fasten the gypsum board face layer to the base layer and resilient channels.

Effect of insulation type: For assemblies with solid wood joists and a single-layer gypsum board ceiling finish, glass fibre insulation reduced the fire resistance by 20% while rock and cellulose fibre insulation increased the fire resistance by 33% and 31%, respectively, compared with a non-insulated assembly. For assemblies with a double-layer gypsum board ceiling finish, glass, rock and cellulose fibre insulation reduced the fire resistance by 16%, 10% and 7.5%, respectively, compared with a non-insulated assembly.

For floor assemblies with wood-I-joists and a single-layer gypsum board ceiling finish, rock fibre insulation increased the fire resistance by 10% while cellulose fibre insulation increased the fire resistance by 24% compared with a non-insulated assembly. For assemblies with a double-layer gypsum board ceiling finish, glass fibre insulation reduced the fire resistance by 7% and rock fibre insulation increased the fire resistance by 7% compared with a non-insulated assembly.

For floor assemblies with steel joists and a double-layer gypsum board ceiling finish, the installation of glass fibre in the floor cavity reduced the fire resistance by 8% compared with a non-insulated assembly.

Effect of number of gypsum board layers: The installation of a second layer of gypsum board to a floor assembly with a single-layer gypsum board ceiling finish increased the fire resistance by 77% for assemblies with solid wood joists and by 71% for assemblies with wood-I-joists.

Effect of joist spacing: For wood-I-joist floor assemblies with glass fibre insulation and a double-layer gypsum board ceiling finish, joist spacing (406 mm o.c. and 610 mm o.c.) affected the fire resistance. An assembly with 610-mm o.c. joist spacing provided 16% more fire resistance than an assembly with 406-mm o.c. spacing.

For steel joist floor assemblies with glass fibre insulation and a double layer of gypsum board ceiling finish, joist spacing (406 mm o.c. and 610 mm o.c.) did not affect the fire resistance.

Effect of resilient channel spacing: For wood-I-joist floor assemblies with glass fibre insulation and a double-layer gypsum board ceiling finish, resilient channel spacing (410 mm o.c. and 610 mm o.c.) affected the fire resistance. Assemblies with 406-mm o.c. channel spacing provided 14% more fire resistance than an assembly with 610-mm o.c. spacing.

Effect of adding concrete topping: Adding concrete topping to an assembly with steel joists and a double-layer gypsum board ceiling finish reduced its fire resistance.

Effect of structural loads: The structural load (75% and 100% of maximum design load) affected the fire resistance of solid wood joist assemblies. Results showed that when loads increased from 75% to 100% of maximum design load, the fire resistance decreased by 14% for non-insulated and by 3% for insulated floor assemblies.

Proposal Made to Code Committee

As an outcome of this study, a proposal that includes more than 600 floor assemblies was submitted to the NBC's Standing Committee on Housing and Small Buildings for possible inclusion in Appendix A of the NBC. ☼

Dr. Mohamed A. Sultan is a Group Leader of the Fire Resistant Construction Sub-Program in the Fire Risk Management Program of IRC.

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Natural Light and Health

Is there a direct link between health, productivity benefits and skylights? Studies are finding that natural lighting can even lead to fewer cavities and better grades for school children.

A survey of five schools by the Alberta Department of Education documented health benefits in children exposed to day lit classrooms over a two-year period. The study found that:

- exposure to full spectrum (natural) light resulted in better attendance
- students in full-spectrum rooms had better dental records and grew more
- day lighted libraries had much less noise, a result of increased concentration levels.

The Alberta study spurred a North Carolina passive-solar design firm to track performance in three day lit schools in the USA. Their research showed that students working in full-spectrum lit classrooms had better test scores than students in conventionally lit schools.

There is also evidence that daylight creates a better office work environment. In a four-storey California office building equipped with advanced lighting, it was the skylit fourth floor that proved the most popular with workers. ☼

Sick School Buildings Video

The review of the video on environmentally sick schools generated considerable interest in the May 1998 issue generated considerable interest. Unfortunately, the phone number provided was not active. The correct numbers for the Practical Allergy Research Foundation are 716-875-5578 or 716-875-0398.

Quiet Fans

Noisy fans can be ineffective because people will not use them or use them for only a short period. The increased use of continuously operating exhaust fans means that efficient and quiet equipment is important. North American fan manufacturers have been slow to design new equipment.

Panasonic has had one of the most energy efficient and quiet fans on the market in the USA for some time: a 50-cfm unit with a noise level of 0.5 sones, and a power consumption of 13 watts, and a 70-cfm unit with a noise level of 0.5 sone, using 15 watts. These units are now available in Canada, but you won't find them at the local lumber yard.

The BC distributor is K.M. Roberts & Assoc.
Tel.: 604-882-8488
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